CLAIMS

What is claimed is:

1. A method for laser shock peening an article, said method comprising:

laser shock peening a first area of a laser shock peening surface with at least one high fluence normal laser beam that is normal with respect to the surface, and

laser shock peening a border area of the surface between the first area and a non-laser shock peened area of the article with at least one first low fluence oblique laser beam that is oblique with respect to the surface.

2. A method as claimed in claim 1, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

3. A method as claimed in claim 2, wherein the high fluence normal laser beam has a fluence of about $200J/cm^2$.

4. A method as claimed in claim 2, wherein the first low fluence oblique laser beam is used to produce only a single row of first low fluence laser shock peened spots in the border area.

5. A method as claimed in claim 4, wherein the high fluence normal laser beam has a fluence of about $200J/cm^2$.

6. A method as claimed in claim 1, further comprising laser shock peening a first portion of the

border area bordering the first area with the first low fluence oblique laser beam laser, laser shock peening a second portion of the border area between the first area and the non-laser shock peened area with a second low fluence oblique laser beam wherein the second low fluence oblique laser beam has a lower fluence than the first low fluence oblique laser beam.

7. A method as claimed in claim 6, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

8. A method as claimed in claim 7, wherein the second low fluence oblique laser beam has a fluence of about 50% of the first low fluence oblique laser beam.

9. A method as claimed in claim 6, wherein the high fluence normal laser beam has a fluence of about $200 J/cm^2$.

10. A method as claimed in claim 9, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

11. A method as claimed in claim 10, wherein the second low fluence oblique laser beam has a fluence of about 50% of the first low fluence oblique laser beam.

12. A method as claimed in claim 1, further comprising laser shock peening the border area with progressively lower fluence laser beams starting with the one first low fluence oblique laser beam wherein

the progressively lower fluence oblique laser beams are in order of greatest fluence to least fluence in a direction outwardly from the first area through the border area to the non-laser shock peened area and at progressively smaller oblique angles with respect to the surface.

13. A method as claimed in claim 1, further comprising:

forming high fluence laser shock peened spots in the first area with the high fluence normal laser beam,

forming first low fluence laser shock peened spots in the border area with the low fluence oblique laser beams, and

operating the high and low fluence oblique laser beams at the same power.

14. A method as claimed in claim 13, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

15. A method as claimed in claim 14, wherein the high fluence normal laser beam has a fluence of about $200J/cm^2$.

16. A method as claimed in claim 13, wherein the first low fluence oblique laser beam is used to produce only a single row of first low fluence laser shock peened spots in the border area.

17. A method as claimed in claim 16, wherein the high fluence normal laser beam has a fluence of about $200J/cm^2$.

18. A method as claimed in claim 13, further comprising laser shock peening a first portion of the border area bordering the first area with the first low fluence oblique laser beam laser, laser shock peening a second portion of the border area between the first area and the non-laser shock peened area with a second low fluence oblique laser beam wherein the second low fluence oblique laser beam has a lower fluence than the first low fluence oblique laser beam.

19. A method as claimed in claim 18, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

20. A method as claimed in claim 19, wherein the second low fluence oblique laser beam has a fluence of about 50% of the first low fluence oblique laser beam.

21. A method as claimed in claim 18, wherein the high fluence normal laser beam has a fluence of about $200 J/cm^2$.

22. A method as claimed in claim 21, wherein the first low fluence oblique laser beam has a fluence of about 50% of the high fluence normal laser beam.

23. A method as claimed in claim 22, wherein the second low fluence oblique laser beam has a fluence of about 50% of the first low fluence oblique laser beam.

24. A method as claimed in claim 13, further comprising laser shock peening the border area with

progressively lower fluence laser beams starting with the one first fluence laser beam wherein the progressively lower fluence laser beams are in order of greatest fluence to least fluence in a direction outwardly from the first area through the border area to the non-laser shock peened area.

25. A laser shock peened article comprising:

a laser shock peened surface having a laser shock peened first area and a laser shock peened border area between the first area and a non-laser shock peened area of the article,

wherein the laser shock peened first area was laser shock peened with at least one high fluence normal laser beam, and

wherein the laser shock peened border area was laser shock peened with at least one first low fluence oblique laser beam.

26. An article as claimed in claim 25, wherein the laser shock peened border area was laser shock peened with the first low fluence oblique laser beam having a fluence of about 50% of the high fluence normal laser beam.

27. An article as claimed in claim 26, wherein the laser shock peened first area was laser shock peened with the high fluence normal laser beam having a fluence of about 200J/cm^2.

28. An article as claimed in claim 26 further comprising only a single row of first low fluence laser shock peened spots in the border area.

29. An article as claimed in claim 28, wherein the laser shock peened first area was laser shock peened with the high fluence normal laser beam having a fluence of about $200J/cm^2$.

30. An article as claimed in claim 25, further comprising:

a first portion of the border area bordering the first area,

a second portion of the border area between the first area and the non-laser shock peened area,

wherein the first portion was laser shock peened with the first low fluence oblique laser beam laser and the second portion was laser shock peened with a second low fluence oblique laser beam, and

wherein the second low fluence oblique laser beam had a lower fluence than the first low fluence oblique laser beam.

31. An article as claimed in claim 30, wherein the first low fluence oblique laser beam had a fluence of about 50% of the high fluence normal laser beam.

32. An article as claimed in claim 31, wherein the second low fluence oblique laser beam had a fluence of about 50% of the first low fluence oblique laser beam.

33. An article as claimed in claim 30, wherein the high fluence normal laser beam had a fluence of about $200J/cm^2$.

34. An article as claimed in claim 33, wherein the first low fluence oblique laser beam had a fluence of about 50% of the high fluence normal laser beam.

35. An article as claimed in claim 34, wherein the second low fluence oblique laser beam had a fluence of about 50% of the first low fluence oblique laser beam.

36. An article as claimed in claim 25, wherein the border area was laser shock peened with progressively lower fluence laser beams starting with the one first fluence laser beam wherein the progressively lower fluence laser beams were in order of greatest fluence to least fluence in a direction outwardly from the first area through the border area to the non-laser shock peened area.

37. An article as claimed in claim 25, further comprising:

overlapping rows of overlapping high fluence laser shock peened spots in the first area formed with the high fluence normal laser beam, and

overlapping first low fluence laser shock peened spots in the border area formed with the low fluence oblique laser beams, and

wherein the high and low fluence oblique laser beams had the same power.

38. An article as claimed in claim 37, wherein the first low fluence oblique laser beam had a fluence of about 50% of the high fluence normal laser beam.

39. An article as claimed in claim 38, wherein the high fluence normal laser beam had a fluence of about $200 J/cm^2$.

40. An article as claimed in claim 37, further comprising only a single row of first low fluence laser shock peened spots in the border area.

41. An article as claimed in claim 40, wherein the high fluence normal laser beam had a fluence of about $200J/cm^2$.

42. An article as claimed in claim 37, further comprising:

a first portion of the border area bordering the first area,

a second portion of the border area between the first area and the non-laser shock peened area,

wherein the first portion was laser shock peened with the first low fluence oblique laser beam laser and the second portion was laser shock peened with a second low fluence oblique laser beam, and

wherein the second low fluence oblique laser beam had a lower fluence than the first low fluence oblique laser beam.

43. An article as claimed in claim 42, wherein the first low fluence oblique laser beam had a fluence of about 50% of the high fluence normal laser beam.

44. An article as claimed in claim 43, wherein the second low fluence oblique laser beam has a fluence of about 50% of the first low fluence oblique laser beam.

45. An article as claimed in claim 42, wherein the high fluence normal laser beam had a fluence of about $200J/cm^2$.

46. An article as claimed in claim 45, wherein the first low fluence oblique laser beam had a fluence of about 50% of the high fluence normal laser beam.

47. An article as claimed in claim 46, wherein the second low fluence oblique laser beam had a fluence of about 50% of the first low fluence oblique laser beam.

48. A method for laser shock peening an article, said method comprising:

laser shock peening a first area of a laser shock peening surface with at least one high fluence laser beam angled at a large oblique angle with respect to the surface, and

laser shock peening a border area of the surface between the first area and a non-laser shock peened area of the article with at least one first low fluence oblique laser beam angled at a low oblique angle with respect to the surface wherein the low oblique angle is smaller than the large oblique angle.

49. A method as claimed in claim 48, wherein the first low fluence oblique laser beam is used to produce only a single row of first low fluence laser shock peened spots in the border area.

50. A method as claimed in claim 48, further comprising laser shock peening a first portion of the border area bordering the first area with the first low fluence oblique laser beam laser, laser shock peening a second portion of the border area between the first area and the non-laser shock peened area with a second low fluence oblique laser beam wherein

the second low fluence oblique laser beam has a lower fluence and a smaller oblique angle to the surface than the first low fluence oblique laser beam.

51. A method as claimed in claim 48, further comprising laser shock peening the border area with progressively lower fluence laser beams starting with the one first low fluence oblique laser beam wherein the progressively lower fluence oblique laser beams are in order of greatest fluence to least fluence in a direction outwardly from the first area through the border area to the non-laser shock peened area and at progressively smaller oblique angles with respect to the surface.

52. A method as claimed in claim 48, further comprising operating the high and low fluence oblique laser beams at the same power.